Study of The Pulmonary Function Test on Women, "The Domestic Biofuel (Wood) Users" in a Tribal Village of Paschim Medinipur, West Bengal, India

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Abstract:

Air pollution is a widespread problem and its impact on the health of the human population is very high. This article provides an overview of the adverse effects of biofuel burning on women's health. The findings of this study were to determine the effect of the use of biofuel (mainly wood) in household works on lung function parameters of the exposed household workers (women). This study was conducted on 30 female subjects who use biofuel and collected the parameters height, weight, Body mass index (BMI), Saturation of peripheral oxygen (SpO2), Systolic and diastolic blood pressure, Peak expiratory flow rate (PEFR) was measured and was compared to the values of the different articles as reference values. Women, exposed to the biofuel smoke suffers from respiratory illness and have decreased PEFR values (l/min). To reduce pollutant exposures, we recommended the use of smokeless chullas as cleaner fuels such as kerosene, charcoal, remembering their poverty levels, as many studies show low pollution level from clean fuels. In the end, this study demonstrates the detrimental consequences of using biomass fuels, particularly wood, on the decline of pulmonary function.

Keywords: Biofuel, Pulmonary function test, Peak expiratory flow rate.

1. Introduction:

Air pollution throughout the world is a threat to us. Now, on the day of our fast-paced lives, we are exposed to polluted air. During cooking one can also get exposed to a huge amount of polluted air and it is a great problem mainly in rural areas. As a result, many diseases occur like Asthma, chronic obstructive pulmonary disease (COPD), Lung cancer, etc. For example, indoor air pollution formed from the burning of traditional biomass fuels like wood, charcoal, animal manure, crop residues, and coal is a significant threat to the health of the public living in small, rural communities and cities in the developing world. Most of these victims are women, in charge of food and nutrition, as well as the infant/young children, as they keep close to the cooking area.[1] About three billion people around the world use biomass (wood, charcoal, plant, and animal manure), and coal as the main source of energy for cooking and heating which is prevalent in China. Biomass is common in all countries, including India, where solid fuels are used and environmental and work-related risk factors cause 40% national burden of disease in India. Both indoor and outdoor air pollution are the leading risk factors. According to the National Census of India (2001), 75% of households use solid fuels (mainly wood and cow dung) and the widespread use of fossil fuels will reach 90% in rural areas.[2] The effects are especially on women, who are primarily engaged in the preparation that is measured by personal monitors and the results show that inhaled particulate matter (PM10) varies from 500-2000 (μg / m3) during a two-hour cooking time without a break, from the combustion of biofuels.[3] The average Indian housewife, women spend more than 6 hours a day in the kitchen and are exposed to the smoke of biomass as a fuel at a very young age (under 15 years of her life), for almost 25% of the total amount of her life. The type of house, the location of the apartment, and the type of fuel that is being used play an important role in women's health.[4] Flammable liquids and gases can result in the emission of the lower fractions of polycyclic aromatic hydrocarbons (PAHs) with high molecular weight, as compared to wood.[5] The infections and deaths caused by acute respiratory infections (ARI) are highest in rural areas, indoor air pollution is most likely to be due to the high levels of smoke from the burning of biofuels. Several studies in developing countries show Indoor particle concentration lasts from several hundred to >10 000 μg / m3. A decrease in its concentration by providing a better kitchen and improving ventilation can reduce the frequency and severity of ARI in developing countries.[6] According to the 1991 Census of India, the rural areas of India 72% of the households rely on wood and plant debris, and about 20% rely on kerosene and fertilizer as the main fuel and particulate matter that is generated from biofuel can reach to the human lungs during breathing that can cause breathing difficulties and the resulting particles are smaller than 10 microns (PM10), is directly related to human health.[7] Biomass smoke and pollution of groundwater are the key factors to enhance the promotion of chronic airway diseases (CAD) for women who live in rural areas.[8] The reduction in pulmonary functions in biomass-exposed women could be due to high exposure to biomass pollutants with inadequate ventilation in the cooking area.[9] The World Health Organization estimated that indoor smoke from solid fuels causes more than 1.6 million deaths and more than 38.5 million disability-adjusted life years, primarily harming children and women. Indoor air pollution from biofuel is ranked 10th among the most preventable risk factors for the global burden of disease, and 4th when considered only in the developing world.[10] In India, out of 166 million households (67%), uses sustainable biofuels for their culinary delights (Census of India, 2011, Global Alliance for Clean Cookstoves, 2013) and the use of the unmodified bio-fuels and lack of natural ventilation of the households in the rural areas lead to high levels of indoor air pollution, and cooking women are affected due to exposure to this.[11]

Against this backdrop, this study is done to understand the adverse effects of biofuel use on lungs by highlighting the measurement of Peak expiratory flow rate.

2. Materials and Methods:

2.1 Sample size:

The study group is comprised of 30 rural female subjects who are chronically exposed to biomass fuel smoke combustion and normal healthy female subjects as a reference value from different articles.

2.2 Area selection:

The Village Muradanga, selected, is near to our Raja N.L Khan women's college (Autonomous) of Paschim Midnapore district, West Bengal and is free from industrial pollution and with negligible vehicular pollution.

2.3 Subject selection:

The subjects were interviewed with a standard respiratory questionnaire, which focused on occupation, use of the type of biomass fuel, ventilation in-house and hours of exposure to biomass fuel etc.

2.3.1 Inclusion Criteria:

- Age 20-50 years.
- Only females
- Cooks only by biofuel mainly wood
- Answers to standard respiratory questionnaires.
- Willing to enrol in the study with written consent.

2.3.2 Exclusion Criteria:

- Pregnant women.
- History of active respiratory infections and cardiovascular diseases.
- Pulmonary embolism.
- Denial for enrolment in the study.
- Recent stroke, eye surgery, thoracic/abdominal surgery.

2.4 Time:

All the experiments were conducted from 10 AM to 1 PM to avoid diurnal variation.

2.5 Height:

The subjects were asked to remove their shoes, heavy outer garments and their height is measured in centimetres by anthropometric rod.

2.6 Weight:

The subjects were asked to remove their shoes, heavy outer garments and stand on the weighing machine and the weight was measured in kilograms.

2.7 BMI:

BMI (Body mass index) is calculated from height and weight of the subjects.

2.8 SpO2 test:

The oxygen saturation value was measured by the pulse oximeter.

2.9 Blood pressure:

The systolic and diastolic blood pressure (mmHg) was measured using manual Sphygmomanometer.

2.10 Peak expiratory flow rate (PEFR) test:

Pulmonary function of these subjects were estimated by measuring peak expiratory flow rate using peak flow meter. To measure the PEFR the subjects were asked to breathe in and out normally into the mouth piece. Then the subject was asked to take deep breath to fill lungs to maximum possible and then exhale into the mouth piece as quickly as possible. It is measured in L/min.

2.11 Statistical Analysis: The statistical analysis was done.

3. Result & Discussion:

The present study was conducted at Muradanga village, Paschim Midnapore district of West Bengal, India. The study data have been collected and compared with the values as a reference of different articles.

After statistical analysis the collected data were compared with different parameters such as age, height, weight, BMI etc. of reference groups [12][13][14]

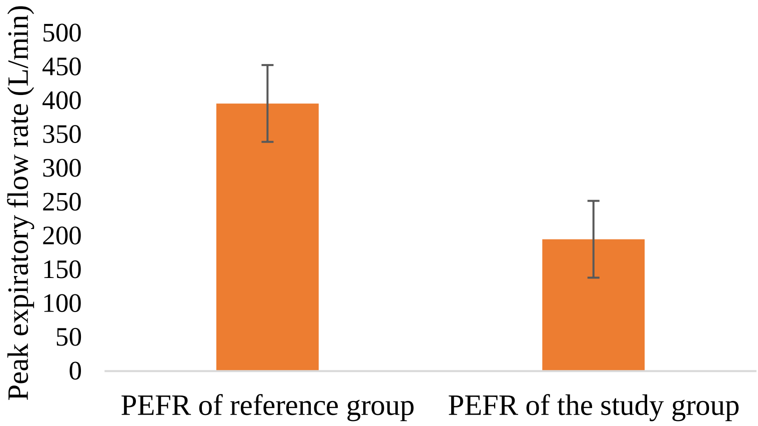
3.1 Total PEFR and Age:

In case of the reference group total PEFR of the age range, 20-50 years is higher than the biofuel users and it is also statistically significant, as described in Table-3.1.1, Figure 3.1.2. The mean PEFR values of the women in the study group at the age range from 20-50 years, is 195±50.22 L/ min and it is compared to the mean PEFR values of the reference group of the same age group which is 395.87 ± 56.81 L/min and statistically, it has a highly significant difference, where $p<0.0001$.

Table 3.1.1: Representation of mean and SD of total PEFR values of study group and reference group

Total Age range (years)	PEFR of reference group (mean±SD) (liter/minute)	PEFR of the study group (mean±SD) (liter/minute)
20-50	395.87 ± 56.81	195±50.22

Figure 3.1.2: Bar diagram represents the comparison of total PEFR (l/min) in between the reference and study group of total age range (20-50) Years.



3.2 The PEFR with different Age groups:

The individuals were divided into 3 groups according to different age ranges and it is found that the PEFR value is high among normal healthy females than the biofuel users female. In statistical analysis, the null hypothesis is rejected and $p<0.0001$. It means there is a highly significant difference in PEFR (L/min) between them, as described in Table-3.2.1, Figure 3.2.2. This data also shows that increasing age leads to a decrease in PEFR value as described by Harpreet Kaur et.al.

Table3.2.1: Representation of mean and SD of PEFR values of study group and reference group at different age intervals.

Age (years)	No. of individuals of reference group	PEFR of the reference group (l/min) mean±SD	No. of individuals of study group	PEFR of study group(l/min) mean±SD
20-30	112	429.64±48.65	17	209.17±51.26
31-40	104	398.65±50.37	8	173±35.32
41-50	84	347.38±37.38	5	182±50.75

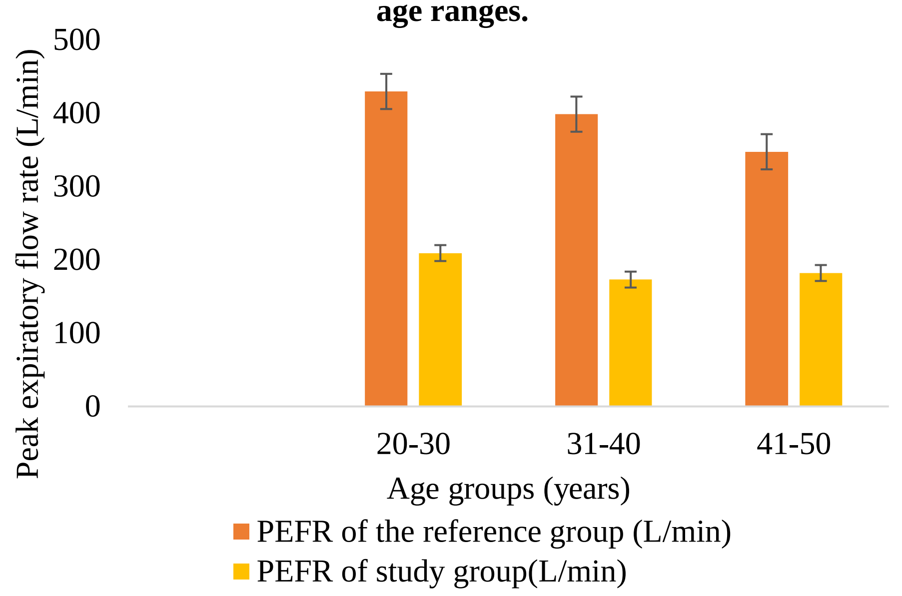


Figure 3.2.2- Bar diagram represents comparison of PEFR (l/min) values between reference and study group according to different age ranges.

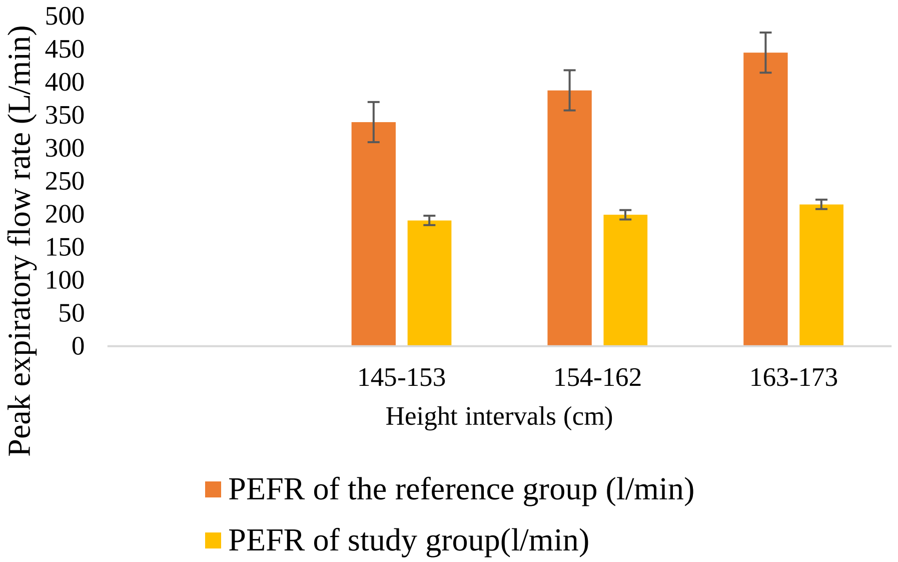
3.3 PEFR with Height:

The individuals were divided into 3 groups again according to different height ranges and it was observed that in the normal healthy female the PEFR is higher than the biofuel users. Here the null hypothesis is also rejected and $p<0.0001$, this means there is an extremely significant difference, as described in the Table-3.3.1, Figure-3.3.2

Table-3.3.1; Representation of mean and SD of PEFR values of study group and reference group at different Height intervals.

Height (cm)	No. of individuals of reference group	PEFR of the reference group (L/min) mean±SD	No. of individuals of study group	PEFR of study group(L/min) mean±SD
145-153	64	339.69±38.98	18	190.67±54.60
154-162	140	387.86±45.90	10	199.2±44.60
163-173	96	445±37.76	2	215±15.00

Figure 3.3.2- Bar diagram represents the comparison of PEFR (L/min) value between reference and study group of different height intervals



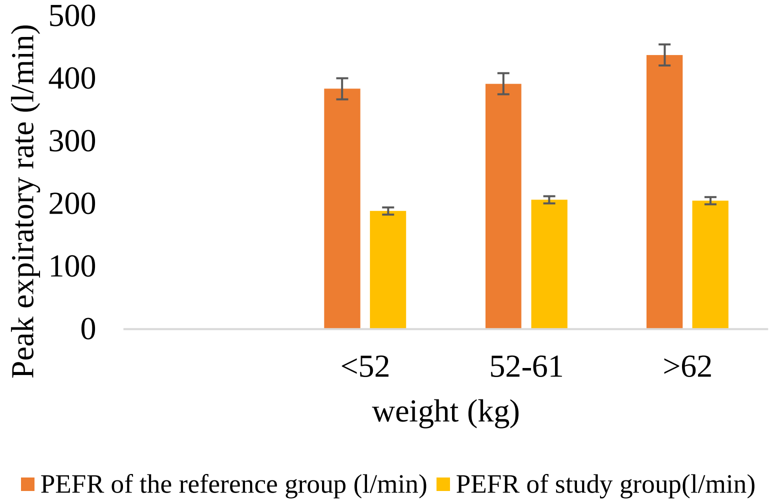
3.4 PEFR with weight:

According to different weight ranges normal women have high PEFR value (l/min) than biofuel users. Here it is also statistically significant where $p<0.0001$, as described in Table-3.4.1 and Figure-3.4.2.

Table-3.4.1; Represents the value of PEFR of study group and reference group according to different Weight ranges

Weight ranges (kg)	No. of individuals of reference group	PEFR of the reference group (l/min) mean±SD	No. of individuals of study group	PEFR of study group(l/min) mean±SD
<52	98	383.67±51.63	19	188.53±53.05
52-61	158	391.77±60.02	9	206.44±45.66
>62	44	437.73±34.36	2	205±25.00

Figure 3.4.2; Bar diagram represents the comparison of PEFR (l/min) between reference and study group according to different weight (kg) ranges.

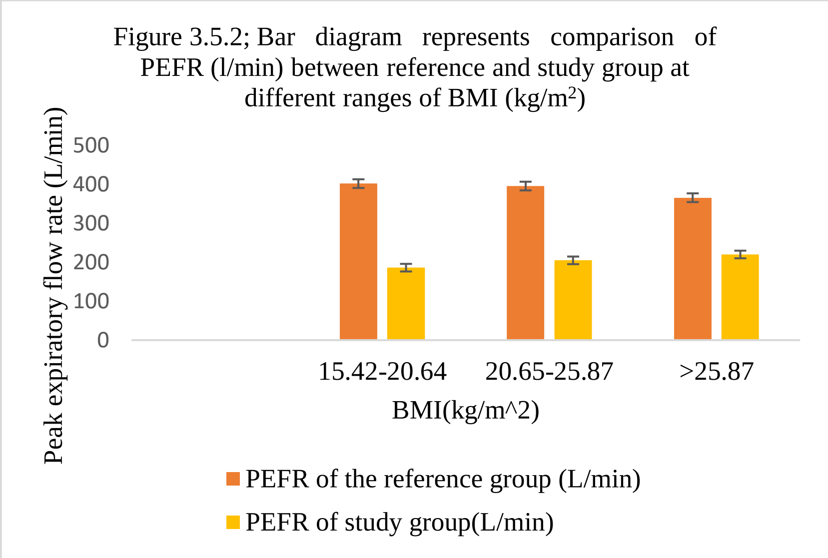


3.5 The PEFR and BMI:

According to BMI the PEFR value of the normal female (reference group), the BMI is highly significant where in 15.42-20.64,20.65-25.87 kg/m^2 BMI the p-value is less than 0.0001 and in case of >25.87 kg/m^2 BMI, the p-value is 0.0002 and it is also highly significant, as described in the Table-3.5.1, Figure 3.5.2.

Table-3.5.1; Comparison of mean and SD of PEFR values of study group and reference group according to different ranges of BMI

BMI (Kg/m^2)	No. of individuals of reference group	PEFR of the reference group (L/min) mean±SD	No. of individuals of study group	PEFR of study group(L/min) mean±SD
15.42-20.64	128	402±51.97	13	186.15±41.42
20.65-25.87	156	395.77±59.73	14	204.93±51.79
>25.87	24	365.83±55.34	3	220±29.44



3.6 Comparison of SpO2 value of study data and reference data:

The SpO2 value of the study group is 97.53±3.79 and 97.98 ± 0.99 of the reference group. In between the SpO2 (mmHg) values of reference data and study data, no significant difference was observed.

3.7 comparison of Blood pressure of Study data and Reference data:

The SBP (mmHg) and DBP (mmHg) values between reference data and study data, a statistically high significant difference was observed as described in Table 3.7.1, Table 3.7.2 and Figure 3.7.3.

Table-3.7.1; Comparison of the mean and SD of systolic and diastolic blood pressure of study data and reference data.

Groups	Systolic blood pressure (mmHg) mean±SD	Diastolic blood pressure (mmHg) mean±SD
Reference group	126.6 ± 16	82.8 ± 8.4
Study group	115.73 ±9.34	73.4±8.66

Figure 3.7.2; Bar diagram represents comparison of Systolic blood pressure (mmHg) between reference and study group.

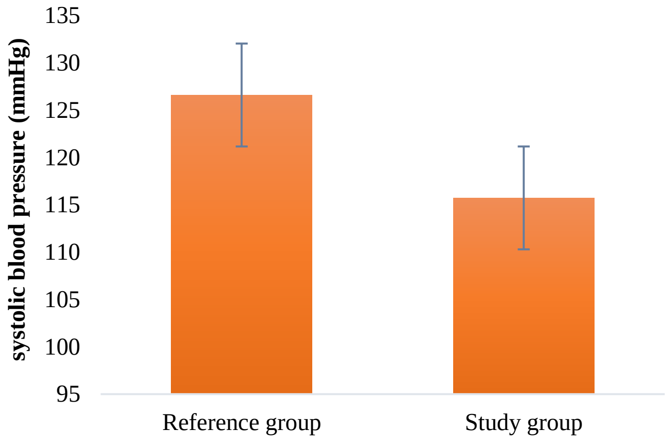
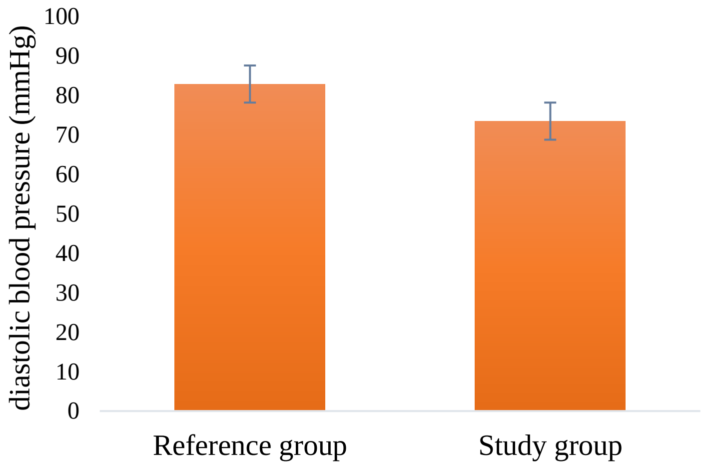


Figure 3.7.4; Bar diagram represents comparison of Diastolic blood pressure (mmHg) between reference and study group.



4. Conclusion:

The findings of this study ultimately demonstrate the harmful impacts of using biomass fuels, particularly wood, on the impairment of pulmonary function. From the above study, we can conclude that the PEFR values of the biofuel user (wood) are lower than the normative reference values. The effects of various factors like height weight BMI on the PEFR values showed a decreased level of PEFR in the case of biofuel users than the normative reference value. Women, exposed to biofuel smoke are vulnerable to respiratory illness as they showed decreased PEFR value (L/min). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) are high in non-smokers as compared to biofuel users. These biofuel users (female) are below the poverty level and their kitchens were much stagnant, there is no availability of fresh air in the kitchen not more than 1 window is present.

Thus, from the above analysis, we can summarize that the oxygen saturation is not hampered only due to biomass combustion though it is the major contributor. The poor socio-economic status of the study group also had an important role to play. To reduce pollutant exposures, we recommended the use of smokeless chullas as cleaner fuels such as kerosene remembering their poverty levels, as many studies showed low pollution levels from clean fuels.

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References:

1.Saha A, Rao NM, Kulkarni PK, Majumdar PK, Saiyed HN. Pulmonary function and fuel use: a population survey. Respiratory research. 2005 Dec 1;6(1):127. DOI:10.1186/1465-9921-6-127

2. Balakrishnan K, Ramaswamy P, Sambandam S, Thangavel G, Ghosh S, Johnson P, Mukhopadhyay K, Venugopal V, Thanasekaraan V. Air pollution from household solid fuel combustion in India: an overview of exposure and health related Page 14 of 15 information to inform health research priorities. Global health action. 2011 Dec 1;4(1):5638. DOI: 10.3402/gha.v4i0.5638

3. Parikh J, Balakrishnan K, Laxmi V, Biswas H. Exposure from cooking with biofuels: pollution monitoring and analysis for rural Tamil Nadu, India. Energy. 2001 Oct 1;26(10):949-62. https://doi.org/10.1016/S0360-5442(01)00043-3

4. Patil PM, Patil RG. CHRONIC OBSTRUCTIVE PULMONARY DISEASES IN WOMEN IN RURAL AREA OF SANGLI DISTRICT, MAHARASHTRA, INDIA.

5. Shen G, Preston W, Ebersviller SM, Williams C, Faircloth JW, Jetter JJ, Hays MD. Polycyclic aromatic hydrocarbons in fine particulate matter emitted from burning kerosene, liquid petroleum gas, and wood fuels in household cookstoves. Energy & Fuels. 2017 Mar 16;31(3):3081- 90. https://doi.org/10.1021/acs.energyfuels.6b02641.

6. Pandey MR, Boleij JS, Smith KR, Wafula EM. Indoor air pollution in developing countries and acute respiratory infection in children. Lancet. 1989(Feb. 25):427-9. https://doi.org/10.1016/S0140-6736(89)92647-0

7. Ingale TL, Ingle ST, Patil B, Dube JK. A comparative study on exposure to indoor air pollution among the urban, sub-urban and rural populations of Jalgaon district.

8. Ekici A, Ekici M, Kurtipek E, Akin A, Arslan M, Kara T, Apaydin Z, Demir S. Obstructive airway diseases in women exposed to biomass smoke. Environmental Research. 2005 Sep 1;99(1):93-8. https://doi.org/10.1016/j.envres.2005.01.004

9. Mahmood T, Jain AK, Verma AK, Dwivedi P. A study to compare pulmonary function in apparently healthy females exposed to biomass fuel combustion versus clean fuel combustion in Allahabad District. Indian Journal of Allergy, Asthma and Immunology. 2019 Jul 1;33(2):79. **DOI:** 10.4103/ijaai.ijaai_4_19

10. Torres-Duque C, Maldonado D, Pérez-Padilla R, Ezzati M, Viegi G. Biomass fuels and respiratory diseases: a review of the evidence. Proceedings of the American Thoracic Society. 2008 Jul 15;5(5):577-90. DOI: 10.1513/pats.200707-100RP.

11. Arora P, Gupta R, Chopra R, Gupta A, Mishra N, Sood S. Effect of chronic exposure to biomass fuel smoke on pulmonary function test parameters. International Journal of Research in Medical Sciences. 2014 Oct;2(4):1488. DOI: 10.5455/2320-6012.ijrms20141145.

12.Kaur H, Singh J, Makkar M, Singh K, Garg R. Variations in the peak expiratory flow rate with various factors in a population of healthy women of the malwa region of Punjab, India. Journal of clinical and diagnostic research: JCDR. 2013 Jun;7(6):1000.

https://doi.org/10.7860%2FJCDR%2F2013%2F5217.3049.

13.Özdal M, Pancar Z, Çinar V, Bilgiç M. Effect of smoking on oxygen saturation in healthy sedentary men and women. EC Pulmonology and Respiratory Medicine. 2017;4(6):178-82. 15. Janzon E, Hedblad

14.B, Berglund G, Engström G. Changes in blood pressure and body weight following smoking cessation in women. Journal of internal medicine. 2004 Feb;255(2):266-72.

https://doi.org/10.1046/j.1365-2796.2003.01293.x